WHAT IS CLAIMED IS:

1. A fiber amplifier system comprising:

a pulsed laser configured to generate light pulses characterized by a pulse length T_{pulse} and a repetition rate;

a fiber amplifier optically coupled to the pulsed laser; and

a nonlinear frequency converting element optically coupled to the fiber amplifier,

wherein the pulse length T_{pulse} is less than about 1.7 nsec and sufficiently large that a frequency bandwidth of the pulses after they emerge from the fiber amplifier is less than an acceptance bandwidth of the nonlinear frequency converting element;

wherein the repetition rate is sufficiently large that amplified spontaneous emission in the fiber amplifier between pulses does not extract more than 50% of the total power from the fiber amplifier.

2. The fiber amplifier system of claim 1 wherein the repetition rate is greater than about 100 kHz.

3. The fiber amplifier system of claim 2 wherein the pulse length T_{pulse} is greater than about 100 psec.

4. The fiber amplifier system of claim 2 wherein the pulsed laser is a passively Q-switched laser (PQSL).

5. The fiber amplifier system of claim 4, further comprising a PQSL pump source optically coupled to the PQSL.

6. The fiber amplifier system of claim 1, further comprising a fiber pump source optically coupled to the fiber amplifier.

7. The fiber amplifier system of claim 1, wherein the fiber amplifier is characterized by a figure of merit z that is greater than about 0.1, wherein z is given by $z = (0.037)\ \beta\ (\mathrm{dB/m})\ A_{mode}\ (\mu m^2)$, where β (dB/m) is the absorption of the fiber amplifier in dB/meter and A_{mode} is the mode area of light to be amplified by the fiber amplifier.

8. The fiber amplifier system of claim 7 wherein the figure of merit z is greater than about 0.5.

9. The fiber amplifier system of claim 7 wherein the fiber amplifier uses a cladding-pumped fiber with an air cladding.

10. The fiber amplifier system of claim 7 wherein the fiber amplifier includes a core of refractive index n_c, a depressed cladding of refractive index n' and an outer cladding of refractive index n_{oc}, wherein $n' < n_{oc} < n_c$.

11. The fiber amplifier system of claim 7 wherein the fiber amplifier has a core with an elliptical cross-section.

12. The fiber amplifier system of claim 7 wherein the fiber amplifier has a W-shaped refractive index profile characterized by a core with a refractive index n_{core} and a radius r_c, a tunnel cladding surrounding the core, the tunnel cladding having a refractive index n' and a cladding region surrounding the tunnel cladding, the cladding region having a refractive index n_{cl}, wherein $n'<n_{cl}<n_{core}$ wherein the core is a single-mode core characterized by a cutoff V-number V_{c1} greater than about 3.0, where $V_{cl} = \frac{2\pi r_c}{\lambda_{cl}}\sqrt{n_{core}^2 - n_{cl}^2}$, and where λ_{c1} is a cutoff wavelength for a second mode of the core.

13. The fiber amplifier system of claim 1 wherein the fiber amplifier amplifies a primary signal having a wavelength ranging from about 860 nm to about 1100 nm.

14. The fiber amplifier system of claim 13 wherein the nonlinear element converts the primary signal to an output signal having a wavelength ranging from about 430 nm to about 550 nm.

15. An image projection system, comprising:
a pulsed laser configured to generate light pulses characterized by a pulse length T_{pulse} and a repetition rate;
a fiber amplifier optically coupled to the pulsed laser;
a nonlinear frequency converting element optically coupled to the fiber amplifier;
an image generator optically coupled to the nonlinear frequency converting element;

and

a scanner optically coupled to the image generator,

wherein the pulse length T_{pulse} is less than about 1.7 nsec and sufficiently large that a frequency bandwidth of the pulses after they emerge from the fiber amplifier is less than an acceptance bandwidth of the nonlinear frequency converting element;

wherein the repetition rate is sufficiently large that amplified spontaneous emission in the fiber amplifier between pulses does not extract more than 50% of the total power from the fiber amplifier.

16. The image projection system of claim 15 wherein the pulsed laser is configured to generate light pulses at a repetition rate of greater than about 100 kHz.

17. The image projection system of claim 16 wherein the pulse length T_{pulse} is greater than about 100 psec.

18. The image projection system of claim 16 wherein the pulsed laser is a passively Q-switched laser (PQSL).

19. The image projection system of claim 18 further comprising a PQSL pump source optically coupled to the PQSL.

20. The image projection system of claim 15 further comprising a fiber pump source optically coupled to the fiber amplifier.

21. The image projection system of claim 15 wherein the fiber amplifier is characterized by a figure of merit z that is greater than about 0.1, wherein z is given by $z = (0.037)\ \beta\ (\mathrm{dB/m})\ A_{mode}\ (\mu m^2)$, where β (dB/m) is the absorption of the fiber amplifier in dB/meter and A_{mode} is the mode area of light to be amplified by the fiber amplifier.

22. The image projection system of claim 21 wherein the figure of merit z is greater than about 0.5.

23. The image projection system of claim 21 wherein the fiber amplifier uses a cladding-pumped fiber with an air cladding.

24. The image projection system of claim 21 wherein the fiber amplifier includes a core of refractive index n_c, a depressed cladding of refractive index n' and an outer cladding of refractive index n_{oc}, wherein $n' < n_{oc} < n_c$.

25. The image projection system of claim 21 wherein the fiber amplifier has a core with an elliptical cross-section.

26. The image projection system of claim 15 wherein the fiber amplifier amplifies a primary signal having a wavelength ranging from about 860 nm to about 1100 nm.

27. The image projection system of claim 26 wherein the nonlinear element converts the primary signal to an output signal having a wavelength ranging from about 430 nm to about 550 nm.

28. A light source comprising:
means for generating light pulses characterized by a pulse length T_{pulse} and a repetition rate;
means for amplifying the light pulses; and
nonlinear means for frequency converting light pulses that have been amplified by the amplifying means,
wherein the pulse length T_{pulse} is less than about 1.7 nsec and sufficiently large that a frequency bandwidth of the pulses after they emerge from the fiber amplifier is less than an acceptance bandwidth of the nonlinear frequency converting element;
wherein the repetition rate is sufficiently large that amplified spontaneous emission in the fiber amplifier between pulses does not extract more than 50% of the total power from the fiber amplifier.

29. For an apparatus having a fiber amplifier optically coupled to the pulsed laser; and a nonlinear frequency converting element optically coupled to the fiber amplifier, a method for optimizing the fiber amplifier, the method comprising:
determining a conversion efficiency δ(p) of the nonlinear frequency converting element as a function of a peak power of an input signal coupled into the fiber amplifier;
calculating an average power of output radiation B(z, p) from the nonlinear frequency converting element as a function of the peak power p and a figure of merit z, where

$z=(0.037)\beta A_{mode}$, where β is a rate of absorption of pump radiation by the fiber amplifier in dB/m, and A_{mode} is a mode area of radiation to be amplified by the fiber amplifier in um^2, and where

$\mathbf{B(z,p)} = \delta(\mathbf{p})\varepsilon\mathbf{P}\left(1-e^{-\frac{z}{p}}\right)$, where ε is a conversion efficiency of the fiber amplifier, P is an average power of a pump radiation coupled into the fiber amplifier;

determining one or more best values p_0 of the peak power p for one or more corresponding values of z by solving $\frac{\partial B(z,p)}{\partial p}\Big|_{p_0} = 0$;

substituting the best values p_0 into B(z, p) to determine one or more best values $B_{best}(z)$ of the average power of the output radiation from the nonlinear frequency converting element as a function of the figure of merit z

determining a desired value B_d of the average power of output radiation from the nonlinear frequency converting element from requirements of an application for which the apparatus is to be used;

from B_d and the one or more values of $B_{best}(z)$ determining a minimum value z_{min} of the figure of merit for the fiber; and

from z_{min} selecting a fiber amplifier characterized by values of β and A_{mode} such that for the fiber amplifier z is greater than or equal to z_{min}.